

A Randomized Trial to Compare Percutaneous Coronary Intervention
Between Massachusetts Hospitals With Cardiac Surgery-On-Site and
Community Hospitals Without Cardiac Surgery-On-Site

The MASS COMM Trial

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PROTOCOL SUMMARY

- Title:** A randomized trial to compare percutaneous coronary intervention between Massachusetts hospitals with cardiac surgery-on-site and community hospitals without cardiac surgery-on-site.
- Objective:** The primary objective of the trial is to compare the acute safety and long term outcomes between hospitals with cardiac surgery on-site (SOS hospitals) and hospitals without cardiac surgery on-site (non-SOS hospitals) for patients with ischemic heart disease treated by elective PCI (stable angina, acute coronary syndrome, or non-Q wave MI).
- Design:** The MASS COMM trial is a prospective, multi-center, randomized controlled two-arm trial of PCI performed at non-SOS hospitals (non-SOS-PCI arm) versus PCI performed at SOS hospitals (SOS-PCI arm). The trial is designed to show non-inferiority of the non-SOS-PCI arm to the SOS-PCI arm. Assuming an expected 30-day major adverse cardiac event rate of 7.0% (safety), and a 12 months major adverse cardiac event rate of 15.0% (efficacy) in each study arm, the trial will have a 5.0% one-sided type I error rate and 85% power for rejecting the null hypotheses of inferiority defined as the ratio of the non-SOS-PCI event rate divided by the SOS-PCI event rate exceeding 1.30 for the 12 months (efficacy) and 1.50 for the 30 days (safety) endpoint, respectively. If these event rate boundaries are exceeded by the non-SOS-PCI arm, the trial will fail to reject the null hypothesis of inferiority.
- Specifically, 3690 subjects will be enrolled in a multi-center randomized controlled trial (RCT), in which eligible subjects will be consented and randomized in a 3:1 ratio at the non-SOS hospitals for PCI to be performed at either the enrolling non-SOS hospital (3 chances out of 4) or a corresponding SOS hospital (1 chance out of 4). An angiographic subset will be reviewed by an independent committee to assess appropriateness and completeness of revascularization. The subset will include a random sample of 10% of subjects selected from all study sites enrolling subjects.
- Primary Endpoints:** The primary safety endpoint is the 30-day major adverse cardiac event (MACE) rate, defined as a composite endpoint of the occurrence of either all cause mortality, myocardial infarction (Q wave and non-Q wave), repeat coronary revascularization (of the target vessel or non-target vessel) by either percutaneous or coronary artery bypass graft [CABG] methods, or stroke, at 30-days. In the case of patients presenting with non-ST elevation myocardial infarction, for the purposes of the primary and other endpoints, myocardial infarction will be defined as re-infarction following the PCI.

The primary efficacy endpoint is the 12 month rate of MACE, defined as a composite endpoint of the occurrence of either all cause mortality, myocardial infarction (Q wave and non-Q wave), repeat coronary revascularization (of the target vessel or non-target vessel) by either percutaneous or coronary artery bypass graft [CABG] methods, or stroke, at 12 months.

- Secondary Endpoints:**
1. All cause mortality at 30 days and 12 months.
 2. Rate of stroke at 30 days and 12 months.
 3. Ischemia-driven TLR and TVR at 12 months.
 4. Rate of stent thrombosis at 12 months.
 5. Any revascularization at 12 months.
 6. Rate of emergency or urgent revascularization through day 30.
 7. Procedure success defined as lesion success without the occurrence of in-hospital MACE.
 8. Major vascular complications including access site complications and major bleeding events requiring transfusion at 30 days.
 9. Completeness of revascularization defined as proportion of epicardial vessels with >70% and <100% stenosis treated with procedural success (assessed in an angiographic subset of patients).
 10. Appropriateness of revascularization defined as the proportion of lesions meeting ACC Class I and II guidelines (assessed in an angiographic subset of patients).

Enrollment: 3690 subjects will be enrolled from approximately 8 MA clinical study sites throughout Massachusetts.

NOTE: Additional sites will be considered according to diagnostic and primary PCI case volume as specified by the Massachusetts Department of Public Health (MA-DPH).

Timeline: Enrollment will begin in June 2006

Study Population: Subjects with ischemic heart disease due to stenotic lesions of native coronary arteries amenable to coronary stenting with FDA-approved coronary stents (both bare metal stents [BMS] and drug eluting stents [DES] are permitted).

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STUDY SITES: **NON-SURGERY ON SITE (NON-SOS) HOSPITALS***
Caritas Norwood Hospital
Brockton Hospital
Lowell General Hospital
Melrose Wakefield
MetroWest Medical Center
Saints Memorial Medical Center
South Shore Hospital
Good Samaritan Hospital

SURGERY ON SITE (SOS) HOSPITALS
Beth Israel Deaconess Medical Center
Boston University Medical Center
Brigham and Women's Hospital
Lahey Clinic
Massachusetts General Hospital
New England Medical Center
St Elizabeth's Hospital

** Participation of non-SOS sites is contingent upon approval by the Massachusetts Department of Public Health (MA-DPH). Additional sites may be added upon approval of diagnostic and primary PCI case volume as specified by the MA-DPH.*

1.0 BACKGROUND AND INTRODUCTION

Introduction

Progress in percutaneous coronary interventions (PCI) has resulted in lower restenosis rates and lower emergency cardiac surgical rescue rates. This improvement in the field has prompted the consideration of moving from the traditional platform of elective PCI at tertiary hospitals with cardiac surgery on site (SOS) to community hospitals without cardiac surgical back-up (non-SOS). The reasons for such consideration are based on the perception of improved convenience due to reduced travel time for the patient, friends, and family, and continuous local involvement of the patient's physicians. In the Commonwealth of Massachusetts, there are no non-SOS hospitals performing elective PCI, although several such hospitals are performing PCI for acute ST-elevation myocardial infarction (STEMI), under the supervision of the Department of Public Health in the Commonwealth of Massachusetts.

PCI for Non-AMI Coronary Ischemia at Hospitals Without Surgical Back-up

The consideration of performing PCI at hospitals without on-site cardiac surgery has been best studied in the setting of acute coronary syndromes. Compared with medical therapy, randomized trials have shown a benefit from early percutaneous coronary interventions (PCI) in acute coronary syndromes, both for acute myocardial infarction (STEMI)[1-3] and acute coronary syndromes (unstable angina)[4]. This utility of PCI was based on standard PCI programs of skilled operators and experienced hospital staffs at hospitals with cardiac surgical back-up. These benefit of PCI over medical therapy in acute coronary syndromes at SOS hospital helped to establish the basis for evaluation of PCI at hospitals without on-site cardiac surgery. The potential incremental value of PCI performed at hospitals with cardiac surgery over those without cardiac surgery, however, may not be limited to the availability of cardiac surgery alone. Hospitals with cardiac surgery programs may also have larger and more complete revascularization services, with greater staff experience, compared with those hospitals without cardiac surgical services[5].

Two implicit comparisons are required to evaluate the consideration of instituting PCI for non-acute MI coronary ischemia at hospitals without cardiac surgery: 1) comparison of outcomes of acute coronary syndromes, including AMI, between PCI (at hospitals without cardiac surgery) and medical therapy, and 2) comparison of non-STEMI PCI outcomes between hospitals with and without cardiac surgery. The first comparisons have been performed retrospectively and prospectively, while the second comparisons have not been performed directly.

The benefit seen from PCI for STEMI (compared with thrombolytic therapy) demonstrated from multicenter randomized trials involving hospitals with cardiac surgery[1], has been seen also in studies from hospitals without cardiac surgery[6-10]. While several of these studies were based on the use of skilled personnel staff from hospitals with elective PCI programs with cardiac surgery, the data suggests that skilled and experienced operators and supportive staff are required, as well as a transportation system that facilitates rapid transfer to a facility that can perform surgical revascularization, if needed. A minority of thought leaders still raise concerns about the wisdom of performing primary PCI for acute MI at hospitals without cardiac surgery[11, 12].

There have, however, been no direct randomized trial data comparing PCI for acute MI at hospitals with cardiac surgery versus hospitals without cardiac surgery. The conclusions made that support PCI for acute MI at hospitals without cardiac surgery are based on observational outcome data and the single randomized trial, Atlantic C-PORT[10]. The 551 patient C-PORT trial, which compared thrombolysis to PCI for the treatment of acute ST-segment elevation MI at hospitals without cardiac surgery, demonstrated a lower incidence of the composite endpoint of death, recurrent MI, and stroke. The difference in the composite endpoint, between PCI versus thrombolysis (16.8% vs. 9.8%), was not driven by death (5.3% vs. 6.2%), but rather by reduced stroke (1.3% vs. 3.5%) and recurrent MI (4.0% vs. 8.8%). These component endpoint reductions are rationally predictable for PCI, since the avoidance of thrombolysis reduces stroke, and the intervention of the index lesion has been shown to reduce recurrent MI[1, 2].

The need for emergent or urgent cardiac surgery services in patients who undergo primary PCI is evident. The randomized 1100 patient multicenter PAMI-2 trial of PCI for acute MI at hospitals with cardiac surgery employed cardiac surgical revascularization during the acute MI index hospitalization in 11% of patients[13]. Surgery within 24 hours was required in 2.5% and emergent surgery for failed PCI in 0.4%.

A comparison of mortality outcomes in randomized trials comparing PCI with thrombolysis for acute MI in the U.S. and the Netherlands (adopted from Aversano[10]), shows a trend for a larger difference in mortality in studies at hospitals with cardiac surgery (Table 1). A direct comparison with hospitals that have cardiac surgery could be enlightening.

Table 1. Death rates by PCI versus thrombolysis, stratified by availability of cardiac surgery in hospital (adopted from Aversano et al).

	No Cardiac Surgery	Cardiac Surgery		
	C-PORT	Weaver	PAMI	Zijlstra
Primary PCI	5.3%	4.4%	2.6%	0%
Thrombolysis	7.1%	6.5%	6.5%	6.0%

The benefit of PCI over medical therapy for patients with acute MI can also be realized by employing a transportation strategy from community hospitals without cardiac surgery to tertiary centers with cardiac surgery. The DANAMI-2 randomized trial demonstrated that PCI for acute MI after transport from a community hospital without PCI capability to a tertiary medical center with PCI capability and cardiac surgical back-up (within 2 hours), was superior to community hospital dispensed thrombolysis[14].

Feasibility of Elective PCI Without Surgical Back-up

The utility of elective PCI at hospitals without cardiac surgery is based on the early and definitive coronary treatment element of PCI over medical therapy for STEMI. Performing elective PCI at hospitals without cardiac surgery remains controversial and has not been well studied. The existing PCI guidelines, written by the American College of Cardiology and American Heart Association Task Force, thus recommend that elective PCI to be performed only at hospitals with on-site cardiac surgical back-up[15].

Few reports have been published that support the utility of elective PCI at hospitals without on-site cardiac surgery, in the current era of glycoprotein IIb/IIIa inhibitors and stents[16-18]. The reports at hospitals without cardiac surgery summarize retrospective or registry prospective studies, with sample sizes that range from 196 to 506 patients. All studies utilized: 1) restricted criteria for patient and lesion complexity, 2) experienced operators from hospitals with cardiac surgery (and in one study, mandatory on-line video consultation with a tertiary hospital). There currently exists no randomized data, nor a sufficient sample size in any of the observational data, to assess the risk of emergent bypass surgery or death complications with precision less than 2%, the current rate of emergent bypass surgery at hospitals that perform PCI with on-site cardiac surgery.

Given the unpredictable risk of even a rare patient who may need immediate surgical attention in order to save his/her life, the rationale for unrestricted PCI without on-site surgical back-up is not without its detractors. Correlation of high volume and experienced PCI operators and support staff with hospitals that have cardiac surgery with outcomes has also been proposed as a factor for consideration of not adopting a community hospital-based PCI strategy[19].

Motivation for Proposed Study

If there is a compelling need to perform PCI in Massachusetts at community hospitals without cardiac surgery, a study should be commissioned, at the very least. The study should involve comparison of complications and late-term revascularization, including the need for emergency surgery, between tertiary (SOS) and community (non-SOS) hospitals.

2.0 STUDY OBJECTIVES

2.1. PRIMARY OBJECTIVE

The primary objective of the trial is to compare the acute safety and long-term outcomes for patients with myocardial ischemia (other than ST-segment elevation myocardial infarction [STEMI]) who are treated by PCI at hospitals without cardiac surgery-on-site (*non-SOS hospitals*) to patients treated at hospitals with cardiac surgery-on-site (*SOS hospitals*). The comparators will be measured as rates of complications (both acute and late-term) and ischemia-driven need for subsequent coronary revascularization in either the target vessels or non-target vessels. This analysis will thus attempt to compare the safety and efficacy of PCI and either accept or reject the null-hypothesis that PCI performed at non-SOS is inferior to that performed at SOS hospitals.

2.1.1 Primary Endpoint

The primary endpoint of this trial will be measured at 30 days (safety) and 12 month (efficacy). The primary endpoint is defined as major adverse cardiac events (MACE), a composite endpoint of the occurrence of death (from all cause), myocardial infarction, repeat coronary revascularization (by surgical or percutaneous methods), or stroke.

2.2. SECONDARY OBJECTIVES

Once the above primary objectives are established, secondary analyses must support patient safety at all levels of potential morbidity.

2.2.1 Secondary Endpoints

The secondary endpoints include both safety and efficacy measures and are as follows:

1. All cause mortality at 30 days and 12 months.
2. Stroke at 30 days and 12 months.
3. Ischemia driven TLR and TVR at 12 months.
4. Rate of stent thrombosis at 12 months.
5. Any coronary revascularization through month 12. Revascularization will be categorized according to relatedness to the target lesion or target vessel (e.g., as either target lesion or target vessel related or non-target lesion or non-target vessel related).
6. Rate of emergency or urgent revascularization through day 30.
7. Procedure success defined as lesion success without the occurrence of in-hospital MACE.
8. Major vascular complications, including access site complications and major bleeding events requiring transfusions, through day 30.
9. Completeness of revascularization, defined as proportion of epicardial vessels with >70% and <100% stenosis treated with procedural success.
10. Appropriateness of revascularization, defined as the proportion of lesions meeting Class I and II criteria per the 2005 Angioplasty Guidelines of AHA/ACC/SCAI or subsequent modifications thereof.

3.0. STUDY DESIGN

The MASS COMM trial is a prospective, multi-center, randomized, controlled two-arm trial of PCI performed at non-SOS hospitals (non-SOS-PCI arm) versus PCI performed at SOS hospitals (SOS-PCI arm). The trial is designed to reject the null-hypothesis of inferiority, and thereby show the non-inferiority of the non-SOS-PCI arm to the SOS-PCI arm. Assuming an expected 30-day major adverse cardiac event rate of 7.0% (safety), and a 12 month major adverse cardiac event rate of 15.0% (efficacy) in each study arm, the trial will have a 5.0% one-sided type I error rate and 85% power for rejecting the null hypotheses of inferiority defined as the ratio of the non-SOS-PCI event rate divided by the SOS-PCI event rate exceeding 1.30 for the 12 months (efficacy) and 1.50 for the 30 days (safety) endpoint, respectively. If these event rate boundaries are exceeded by the non-SOS-PCI arm, the trial will fail to reject the null hypothesis of inferiority.

Specifically, 3690 subjects will be enrolled in a multi-center, randomized, controlled trial (RCT), in which eligible subjects will be consented and randomized in a 3:1 ratio at the non-SOS hospitals for PCI to be performed at either the enrolling non-SOS hospital (3 chances out of 4) or a corresponding SOS hospital (1 chance out of 4).

Eligible subjects will be recruited from the patient pool of all subjects undergoing diagnostic catheterization for treatment of known or suspected coronary artery disease at non-SOS hospitals (subjects undergoing diagnostic catheterization for planned valve surgery or cardiac transplantation are not included in the pool of recruited subjects recorded on the site screening log). Subjects must meet eligibility criteria and agree to participate in the study, including willingness to be randomized and transported or rescheduled for treatment at a SOS hospital with on-site cardiac surgery. The safety and effectiveness of PCI performed in each clinical setting will be evaluated by analyzing all clinical endpoints, ECG data, a subset of angiographic data and MACE. All subjects will undergo clinical assessments at 30 days, and 12 months. Study subjects may choose to have their post-PCI follow-up care performed at their local medical provider's site. The research staff at the study sites may enroll study subjects who choose local follow-up by collaborating with the local medical provider (and staff) to obtain the necessary 30 day and cumulative 12 month follow-up medical information necessary for data collection and determination of study endpoints. Study site coordinators may also contact subjects directly to ascertain their health care status, in addition to collaborating with the subject's local medical provider.

Since this study will evaluate the rates of complications and late-term revascularization, including the need for emergency surgery, between tertiary (SOS) and community (non-SOS) hospitals, staged-revascularization of study subjects is limited to patients with specific medical criteria justifying a staged procedure. Patients who present with the following criteria prior to their index procedure are eligible for a staged procedure and study enrollment:

1. eGFR < 60 ml/min, and/or
2. creatinine > 1.5 mg/dl

Additionally, study subjects who qualify for staged procedures by these criteria are also requested to have their second portion of the staged procedure performed no sooner than 14 days unless clinically necessary and at least within 30 days of first procedure **at the site to which they were randomized**. In this cohort of subjects treated for a pre-approved staged procedure, the period for 30 day endpoint determination of MACE will begin with the first index procedure and extend to 30 days after the second portion of the staged procedure. Similarly, the period for 12 month endpoint determination of MACE begins with the first index procedure and extends to 12 months after the second portion of the staged procedure.

An adjudication process will be conducted by an independent Clinical Events Committee (CEC) to determine the occurrence of clinical study endpoints (MACE, procedure success, major vascular complications and appropriateness and completeness of revascularization in a subset of subjects, per the ACC/AHA/SCAI 2005 Guideline update for Percutaneous Coronary Intervention provided in the Manual of Operations) for the duration of the study. The CEC will be blinded to the assigned treatment (PCI setting of SOS vs. non-SOS site) arm for the entire study. In addition, an angiographic subset will be reviewed by the independent CEC to assess appropriateness and completeness of revascularization. The subset will include a random sample of 10% of subjects selected from all study sites enrolling subjects.

Participating non-SOS hospitals are responsible for ensuring appropriate and safe enrollment of subjects. For sites that do not already provide primary angioplasty medical coverage on a daily basis throughout the day (e.g., 24/7), a medical team must be available and on-call to deal with complications that result from the study procedure. Any patient at a non-SOS site who consents to participate in the MASS COMM trial on a day where there is no 24 hour post-procedure interventional team coverage at the non-SOS site cannot be randomized that day. Participating non-SOS hospitals are responsible for ensuring systems and processes are in place with SOS and partnering hospitals for surgical support for (1) transport and/or efficient scheduling of subjects randomized to SOS PCI arm and (2) efficient and rapid transport for subjects in whom a procedural complication warrants surgical intervention.

In the case of subjects randomized to SOS PCI, every effort must be made for same day transfer and scheduling of PCI at SOS site with subject's non-SOS provider, and that such delayed PCI will be performed no later than 3 days from randomization.

For subjects requiring urgent or emergency surgical intervention due to non-SOS PCI procedural complication, the non-SOS hospital must transport the study subject to the SOS partnering hospital providing cardiac surgical support. Transport will require rapid and efficient transfer, specifically: availability of ambulance transport must arrive at non-SOS hospital within 30 minutes of request by catheterization staff due to procedural complication. Every effort must be made to ensure arrival of subject at partnering surgical hospital within 60 minutes of decision to transport study subject.

3.1 ELIGIBILITY CRITERIA

3.1.1 Inclusion Criteria

Candidates for this study must meet ALL of the following criteria:

1. Subject is ≥ 18 years old.
2. Subject requires single- or multi-vessel percutaneous coronary intervention (PCI) of *de novo* or restenotic target lesion (including in-stent restenotic lesions).

N.B. staged procedure will not be considered to meet the endpoint component of repeat revascularization if either of the following pre-catheterization procedure qualifying clinical laboratory values are met:

- eGFR < 60 ml/min or
 - creatinine > 1.5 mg/dl
3. Subject's lesion(s) is (are) amenable to stent treatment with currently available FDA-approved bare metal or drug eluting stents.
 4. Subject is an acceptable candidate for elective, urgent or emergency CABG.
 5. Subject has clinical evidence of ischemic heart disease in terms of a positive functional study, or documented symptoms.
 6. Documented stable angina pectoris [Canadian Cardiovascular Society Classification (CCS) 1, 2, 3, or 4], unstable angina pectoris with documented ischemia (Braunwald Class IB-C, IIB-C, or IIIB-C), non-ST segment elevation myocardial infarction, or documented silent ischemia.
 7. Subject is willing and able to undergo percutaneous intervention at SOS hospital, if randomized to SOS study arm.
 8. Subject and the treating physician agree that the subject will comply with all follow-up evaluations.
 9. Subject has been informed of the nature of the study and agrees to its provisions and has provided written informed consent as approved by the Institutional Review Board/Ethics Committee of the respective clinical site.

Angiographic Inclusion Criteria

10. The target lesion(s) is (are) *de novo* or restenotic (including in-stent restenotic) native coronary artery lesion(s) with ≥ 50 and $< 100\%$ stenosis (visual estimate), or the target lesion is an acute (less than 1 month) total occlusion as evidenced by clinical symptoms.

11. Target lesions(s) is (are) located in an infarct (if not treated with primary PCI) or non-infarct-related artery with a 70% or greater stenosis (by visual estimate) > 72 hours following the STEMI.

Lesions treated with PCI > 72 hours following STEMI would be subject to the same protocol inclusion/exclusion criteria listed above and below with the exception that a target lesion of 70% or greater stenosis may be treated with or without symptoms or abnormal stress test).

3.1.2. Exclusion Criteria

Subjects will be excluded if **ANY** of the following conditions apply:

1. The patient is pregnant or breastfeeding.
2. Evidence of ST segment elevation myocardial infarction within 72 hours of the intended treatment on infarct related or non-infarct related artery.
3. Cardiogenic shock on presentation or during current hospitalization.
4. Left ventricular ejection fraction less than 20%.
5. Known allergies to: aspirin, clopidogrel (Plavix[®]), prasugrel (Effient[®]), and ticlopidine (Ticlid[®]), heparin, bivalirudin, stainless steel, or contrast agent (which cannot be adequately premedicated).
6. A platelet count <75,000 cells/mm³ or >700,000 cells/mm³ or a WBC <3,000 cells/mm³.
7. Acute or chronic renal dysfunction (creatinine >2.5 mg/dl or >150μmol/L).
8. Subject is currently participating in an investigational drug or device study that has not completed the primary endpoint or that clinically interferes with the current study endpoints. (Note: Trials requiring extended follow-up for products that were investigational, but have since become commercially available, are not considered investigational trials).
9. Prior participation in this study.
10. Within 30 days prior to the index study procedure, the subject has undergone a previous coronary interventional procedure of any kind. Note: This exclusion criterion does not apply to post-STEMI patients.
11. Stroke or transient ischemic attack within the prior 3 months.
12. Active peptic ulcer or upper GI bleeding within the prior 3 months.

13. Subject has active sepsis.
14. Unprotected left main coronary artery disease (stenosis >50%).
15. In the investigator's opinion, subject has a co-morbid condition(s) that could limit the life expectancy to less than one year, or limit the subject's ability to participate in the study or comply with follow-up requirements or impact the scientific integrity of the study.

Angiographic Exclusion Criteria

16. Subject has normal or insignificant coronaries (i.e. coronary lesion(s) < 50% stenosis).
17. Any target vessel has evidence of:
 - a. excessive thrombus (e.g. requires target vessel thrombectomy)
 - b. tortuosity (>60 degree angle) that makes it unsuitable for proper stent delivery and deployment,
 - c. heavy calcification.
18. Any target lesion requires treatment with a device other than PTCA prior to stent placement (e.g. but not limited to, directional coronary atherectomy, excimer laser, rotational atherectomy, etc.).
19. Any lesion that is located in a saphenous vein graft, however, lesions located within the native vessel but accessed through the graft are eligible.
20. The target vessel is in a "last remaining" epicardial vessel (e.g. >2 non-target epicardial vessels and the bypass grafts to these territories [if present] are totally occluded).

Subjects who meet all of the inclusion criteria and none of the exclusion criteria may be enrolled into the study.

3.2 INFORMED CONSENT

Eligible subjects will be recruited and consented from the patient pool of all subjects undergoing diagnostic catheterization for treatment of known or suspected coronary artery disease at non-SOS hospitals (subjects undergoing diagnostic catheterization for planned valve surgery or cardiac transplantation are not included in the pool of consented and recruited subjects recorded on the site screening log).

Subjects will sign a consent form describing the study purpose and full study procedures and risks, specifically the investigational nature of PCI performed at hospitals with no surgery on site, and discomforts (including need for transport or delayed scheduling of procedure to be performed at participating SOS hospital), as well as the benefits. Depending upon institutional requirements, subjects may be asked to sign an additional informed consent form at the SOS site after randomization.

A member of the each study site research team (catheterization lab nurses, fellows, or physicians) will approach the patient to obtain written informed consent prior to any screening or interventional procedure being performed. The background of the proposed study and the benefits and risks of the procedures and study should be explained to the patient. The patient (or legal representative) must sign the consent form prior to randomization. This form or a modification of it must have prior approval of the study site's Institutional Review Board (IRB). Failure to provide informed consent renders the patient ineligible for study participation and data collection.

3.3 SUBJECT RECRUITMENT

Subject screening and eligibility will be documented on the *Subject Screening and Eligibility Log* for all subjects. The purpose of the screening log is to capture all patients screened for consideration of enrollment into the study and includes collection of the following data: screening date, screening number, name code initials, gender, age, whether the consent form was signed, consent date (if applicable), eligibility (both clinical and angiographic), randomization, whether a stage procedure is needed or planned, and additional comments. Research personnel at each site will record the criteria by which subjects are excluded or will record the date of subject enrollment. Adult patients will be enrolled without regard to age or sex and will be included or excluded from enrollment based upon the inclusion and exclusion criteria listed above. Completed screening logs should be submitted to the Data Coordinating Center (HCRI) on a weekly basis.

3.4 RANDOMIZATION

Subjects will be randomized after it has been determined that the subject meets all medical and angiographic eligibility criteria. Randomization may require either ambulance transport to the appropriate SOS participating hospital for PCI procedure (for subjects in whom removing sheath access is not practical) or subjects may be scheduled for their assigned procedure at the SOS hospital with their community provider later the same day (no subject should be delayed more than 3 days for assigned SOS PCI). Randomization will occur through the use of sealed envelopes located in the enrolling non-SOS cardiac catheterization laboratory. The randomization of subjects will be stratified based upon diabetic status (presence or absence). The patient is considered enrolled into the study when the patient is randomized.

Responsibility for communicating SOS site availability in order to accept a randomized patient transfer is critical for allowing randomization and recruiting of patients. SOS hospitals must inform their enrolling non-SOS partner hospital if the SOS hospital is diverting patients; procedures should not be performed at non-SOS hospital until the SOS hospital is back "on-line". In addition, the intent is for most patients to be treated on the same day as the randomization is performed. If beds at an SOS hospital are not immediately available, the partnering non-SOS hospital should not randomize patients to that SOS hospital.

4.0 STUDY PROCEDURES

4.1 PRE-PROCEDURE

All candidates for study entry should be screened for eligibility. Prior to any study-specific tests or procedures, written informed consent must be obtained from the subject.

4.2 DETERMINATION FOR STUDY-PERMITTED STAGED PROCEDURES

Staged-revascularization of study subjects is limited to patients with specific medical criteria justifying a staged procedure. Patients who present with the following criteria prior to their index procedure are eligible for a staged procedure and study enrollment based upon laboratory values documented prior to randomization:

1. eGFR < 60 ml/min, and/or
2. creatinine > 1.5 mg/dl

For all other patients, including those in whom it is uncertain whether a second stenosis will require revascularization, planned staging is not recognized and therefore a repeat procedure will be considered an endpoint.

Clinical monitoring will be performed to evaluate whether the above criteria existed prior to randomization (10% source document verification). Investigators must document whether staging is planned, and the supporting laboratory test values on the case report forms.

4.3 BASELINE PROCEDURES

The following tests and procedures must be performed prior to the index procedure to verify eligibility:

- Physical examination and relevant cardiac medical history including angina status or myocardial ischemia assessment, patient demographic information and cardiac risk factor history (*may be performed within 7 days prior to the index procedure*);
- Routine laboratory tests including complete blood count (CBC), platelet count, and serum creatinine obtained within 14 days prior to the index procedure;
- Baseline cardiac enzymes (CK) and isoenzymes (CK-MB) obtained within 24 hours of the index procedure. If CK levels are normal and CK-MB are not standard of care for the site, then failure to obtain baseline CK-MB will not be considered a protocol deviation if the site has provided a memo to HCRI in advance.
- A 12-lead electrocardiogram obtained within 7 days prior to the procedure, for subjects scheduled for elective PCI. Subjects with ischemic symptoms suggestive of a possible MI in evolution must have a 12 lead ECG within 24 hours prior to randomization.
- Assessment of left ventricular function by any invasive or non-invasive method (e.g., left ventriculography or echocardiography) within 30 days of the procedure (pre-randomization).
- Reference vessel characteristics (diameter, tortuosity) and lesion characteristics (CASS site, lesion length, calcification, lesion pre-treatments performed, pre- and post- TIMI flow, lesion classification) will be collected on eCRF.

- Procedural information to be collected include: procedure start and stop time, volume of contrast, devices used, peri-procedural complications (including final dissection, if any) and achievement of procedural success.

4.4 CONCOMITANT MEDICATIONS

It is strongly recommended that all subjects receive the medication regimen listed below. All medications administered should be recorded in the subject's medical record. The use of procedural medications (heparin, GPIIb/IIIa receptor inhibitors, etc) must be captured and reported. Anti-platelet and anti-coagulant medication taken by the subject (e.g., ASA, Clopidogrel, Ticlopidine, Prasugrel), including dosage, must be reported on the eCRF throughout the duration of the trial.

TABLE 2. Concomitant Medications

Timing	Medication	Procedure
Prior to Stent Implant	IV Heparin or bivalirudin	Administer per routine hospital practice for purpose of elective PCI procedure
	Aspirin	At least 325 mg QD or per routine hospital practice for purpose of elective PCI procedure
	Clopidogrel ^{a,b} OR	Administer 300-600 mg loading dose
	Prasugrel	Administer 60 mg loading dose
During Procedure	IV Heparin or bivalirudin	Per routine hospital practice
	IIb/IIIa Inhibitor	Per clinical judgment
	Intracoronary Nitroglycerin	50-200 mcg <i>prior to baseline</i> and <i>post intervention angiograms</i> ;
Post-Implant	IV Heparin or bivalirudin	Maintenance dose per routine hospital practice
	IIb/IIIa Inhibitor	Maintenance dose per routine hospital practice
	Aspirin	325 mg QD for at least 12 months, unless documented medical reason for not continuing at this dose.
	Clopidogrel ^a OR	75 mg po QD (for 3-6 months)
	Prasugrel	5-10 mg po QD

^a Investigator may substitute ticlopidine for subjects who are allergic or sensitive to clopidogrel, Subjects on ticlopidine are to have CBCs performed per the drug labeling. Minimum duration per indications for use for stent (1 month for bare metal, 3 months for Cypher, 6 months for Taxus). Clopidogrel may be continued beyond minimum duration per clinical judgment.

^b No additional loading dose is to be given to subjects who have been receiving clopidogrel ≥48 hours prior to the procedure.

4.5 STENTING PROCEDURE

4.5.1. Stent Implant Procedure

The stent implant procedure will be performed in accordance with the device Instructions for Use (IFU). Research catheterization staff must take care in their use of FDA-approved devices only.

The appropriate stent size for the target lesion will be selected (≥ 4 mm longer than the lesion length). The selected stent should be long enough to cover the lesion and pre-dilated area completely. Using the balloon markers that bracket the stent, the delivery system will be advanced over the guidewire until the ends of the stent bracket the target lesion. Stent position will be confirmed by angiography.

Post-dilatation may be performed at the operator's discretion. It is recommended that the post-dilatation technique be carefully performed to avoid balloon injury to ANY segment of the vessel that will not be entirely covered by the stent.

It is recommended that stents be fully deployed to normal reference vessel diameter (RVD) on each side to ensure complete apposition. Optimal stent expansion requires that the stent be in full contact with the arterial wall. Do not leave any injured area uncovered by a study stent. If post dilatation is required for optimal stent placement, post dilate carefully with a balloon shorter than the segment covered by the study stent. Limit post dilatation to within the boundaries of the stent. The use of IVUS may be performed at the discretion of the interventionalist.

Upon completion of treatment for each lesion, intracoronary injection of nitroglycerin (NTG) must be administered and final angiography of the vessel performed in the two near-orthogonal views that were taken at baseline, showing each target lesion free of foreshortening or vessel overlap, using a 6 French or larger guiding catheter.

4.5.2. Bailout or Incomplete Coverage Procedures

If the patient experiences a major dissection or an occlusive complication manifested as decreased target vessel flow, chest pain or ischemic electrocardiogram (ECG) changes that do not respond to repeat balloon inflations or intracoronary vasodilators (NTG, verapamil, diltiazem), or in cases of incomplete lesion coverage, other bailout procedures may be performed, which may include additional stent placement.

If more than one stent is needed to cover the lesion completely, it is recommended that the stents overlap by 2-3 mm. Stent length will be counted as described on its product label; overlap does not constitute a reduction of total stent length.

4.5.3 Non-Intervention Post Randomization

If the randomized subject does not undergo PCI with implantation of a stent, the reason for non-intervention must be documented in the eCRF by the interventionalist making the decision to not perform PCI post randomization.

4.6 POST PROCEDURE

The procedure is considered complete after final angiographic recording of the treatment area, and once the guiding catheter has been removed from the subject. Thereafter, if a guiding catheter is re-introduced, this is considered a repeat intervention, which must be documented.

Immediately following the procedure:

- Heparin or bivalirudin should be continued or discontinued, per hospital standard practice
- ACT should be monitored per hospital standard practice
- Vascular sheaths should be removed per hospital standard practice
- Approved vascular closure devices may be used at the discretion of the investigator

4.7 LABORATORY AND ECG ASSESSMENTS THROUGH DISCHARGE

IMPORTANT: The tests outlined below must be performed whether or not they are considered part of the Investigator's standard of clinical practice.

A 12-lead ECG will be performed pre-procedure, prior to hospital discharge and at both the 30 day and 12 month follow up visits. Additional ECG recordings must be obtained with any suspicious ischemic episode.

Cardiac enzymes, CK and CK-MB, are to be measured at one time point post procedure: between 12-24 hours post-index procedure or prior to hospital discharge, whichever comes first.

Hospital discharge data collection will include eCRF documentation of all in-hospital cardiac-related complications and events (MI, repeat interventions, change in angina status, or stroke), peak creatinine, bleeding complications (including access site complications) and the occurrence of death.

4.8 POST PROCEDURE FOLLOW-UP EVALUATIONS

All study subjects will be followed through hospital discharge and will undergo follow-up evaluations at the following time points.

4.8.1 Thirty-day Follow-up (Clinic*):

Study subject follow-up clinic evaluation must occur at 30-days (+ 7 days) post-procedure. For subjects with qualifying staged-procedures, this 30 day follow-up assessment occurs 30 days (+7 days) post the second staged procedure and **data will be recorded for events that occur between the first index procedure and 30 days after the second staged procedure.** The assessment will consist of:

- Angina status (according to the Canadian Cardiovascular Society Classification of angina),

- Major study endpoint events of death, MI, stroke and major vascular complications and bleeding complications,
 - Concomitant anti-platelet/anti-coagulant medications,
 - Any interventional treatment that occurred since the previous contact (*e.g.*, repeat revascularization by surgical or percutaneous methods). This will include documentation regarding subject need for revascularization based upon clinical status, and
 - 12- lead ECG.
- * Clinical visit can be with physician or research coordinator.

4.8.2 Twelve Months Post-Procedure (*Clinic):**

A clinic visit will occur at 12 months (± 30 days) post-procedure. For subjects with qualifying staged-procedures, this 12 months follow-up assessment occurs 12 months ($+30$ days) post the second staged procedure. **Data will be recorded for events that occur between the first index procedure and through 12 month after completion of the second staged procedure.** This visit will consist of:

- Angina status assessment (according to the Canadian Cardiovascular Society Classification of angina),
- Major study endpoint events of death, MI, and stroke,
- Concomitant anti-platelet/anti-coagulant medications,
- Any interventional treatment that occurred since the previous contact (*e.g.*, repeat revascularization by percutaneous or surgical methods). This will include documentation regarding subject need for revascularization based upon clinical status, and
- 12- lead ECG,

* Clinical visit can be with physician or research coordinator.

4.8.3. Additional Angiography and Revascularization

All subsequent angiograms or revascularizations performed on the target vessel during the 12 month follow-up period should be preceded by a physician evaluation during which the physician will indicate whether or not the subject's clinical status warrants revascularization. Any subsequent revascularization procedures should not be performed at non-SOS hospitals with the exception of patients with STEMI as per standard practice at the non-SOS site. Results of the angiograms and catheterization reports along with case report form data will be used in the adjudication of the study endpoints.

In some cases, recurrent ischemia may develop less than 30 days after successful stent placement. If angiography demonstrates a significant stenosis or sub-acute thrombotic occlusion of the target vessel, the subject will be considered an acute failure, and will continue to be included in the follow-up analyses that measure restenosis. In this situation, recurrent ischemia will be attributed to sub-acute closure, rather than restenosis.

Table 3. Schedule of Events

Schedule of Events	Pre-Procedure (Within 7 days)	Procedure	Post- Procedure	Discharge (No more than 12 hours prior)	30 Days (+ 7 days) Follow- Up Visit	12 Months (± 30 days) Follow- Up Visit
					Clinic	Clinic
Determine Eligibility	X	X ¹				
Obtain Informed Consent	X					
Demographic Information	X					
Medical and Cardiac History	X					
Angina Status	X			X	X	X
CBC	X ²			X		
Cardiac Enzymes (CK, CK-MB ^{3,4})	X ³ (within 24 hours)		X ⁴ (12-24 hours or prior to discharge if discharge before 12 hours)			
12 Lead ECG	X (within 7 days)			X	X	X
ACT		X				
Angiography and Randomization		X ⁵				
Revascularization procedure(s)		X				
PCI related medications (procedural, anti- platelet/anti-thrombin, & anti-coagulants)		X		X	X	X
Study Endpoint Assessment		X		X	X	X

¹ ECG performed within 7 days prior to randomization may be used to qualify the patient for subjects undergoing elective PCI and for subjects without signs and symptoms of an MI in evolution. Subjects with ischemic symptoms suggestive of a possible MI in evolution must have a 12 lead ECG within 24 hours prior to randomization.

² Routine laboratory tests including complete blood count (CBC), platelet count, and serum creatinine may be obtained within 14 days prior to the index procedure.

³ If CK levels are normal and CK-MB are not standard of care for the site, then failure to obtain baseline CK-MB will not be considered a protocol deviation if the site has provided a memo to HCRI in advance.

⁴ If institutional procedures prevent testing of CK-MB when CK value is normal, sites must arrange to have CK-MB measured on normal CK values post procedure.

⁵ Final eligibility and randomization is based upon angiographic eligibility criteria.

4.9 TRANSPORT FOR SURGICAL INTERVENTION

Subjects in whom a procedural complication warrants surgical intervention will be transported to the SOS partnering hospital providing cardiac surgical support. Transport will require rapid and efficient transfer, specifically: ambulance transport must be on site or arrive on-site at the non-SOS hospital within 30 minutes of request by catheterization staff due to procedural complication. Every effort must be made to ensure arrival of subject at partnering surgical hospital within 60 minutes of decision to transport study subject.

Each SOS hospital must inform its enrolling non-SOS partner site if the SOS site is diverting patients; randomization or PCI should not be performed at the non-SOS sites until the SOS hospital is back “on-line” and accepting patient transfers.

Data collection in the instance of urgent and emergency surgical intervention requires that the time of procedural complication, request for ambulance transport, arrival at surgical hospital and time of surgical intervention be recorded. Every effort must be made to ensure that the emergency surgical intervention begins within 120 minutes of procedural complication and interventionalist’s decision to transport for emergency surgical intervention.

4.10 REPEAT REVASCULARIZATION PROCEDURES

If subjects require repeat revascularization at any time (beginning from the time the interventionalist completes the index procedure and subject first exits the catheterization lab), the repeat procedure will be conducted at the SOS-partner study site with the exception of patients with STEMI as per standard practice at the non-SOS site. This requirement does not apply to those subjects who had permitted staged procedures for qualifying for clinical criteria as outlined in section 4.2.

For those subjects with qualifying staged procedures, any repeat revascularization (beginning from the time the subject exits the catheterization lab after completion of the second portion of the staged procedure) will be conducted at the partner SOS study site with the exception of patients with STEMI as per standard practice at the non-SOS site.

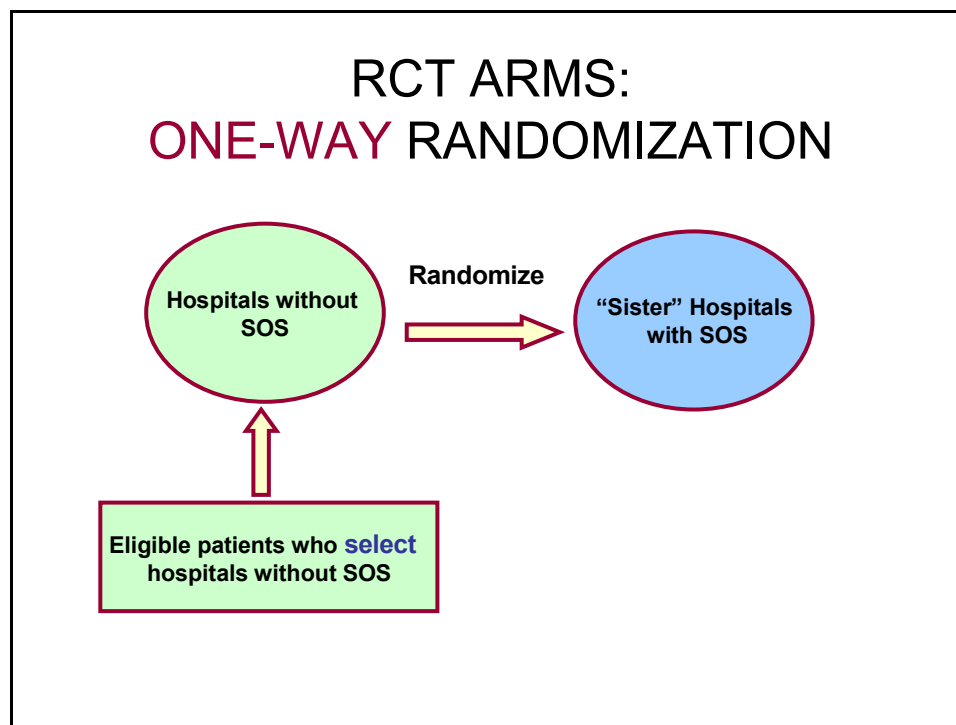
4.11 STUDY TERMINATION

MA-DPH may terminate the study at any time. If the study is terminated prior to the completion of expected enrollment for any reason, all participating centers will be notified within five working days. All patients already enrolled will continue to be followed for the planned course of study described in this protocol. The study will be terminated following the final follow-up visit of the last enrolled patient.

5.0 STATISTICAL DESIGN

5.1 OVERVIEW

The design is a one-way randomized trial. There are therefore two groups of patients: 2767 randomized to hospitals without SOS (non-SOS) and 923 randomized to hospitals with SOS.



5.2 STATISTICAL HYPOTHESES:

Non-inferiority of PCI at sites without SOS is hypothesized for both the effectiveness and safety endpoints.

Effectiveness Endpoint: μ_X = fraction in group X (all-cause mortality, MI, repeat coronary revascularization, or stroke at 12 months from PCI)

Null Hypothesis: $\mu_{\text{NON-SOS}} / \mu_{\text{SOS}} \geq 1.30$

Alternative: $\mu_{\text{NON-SOS}} / \mu_{\text{SOS}} < 1.30$

Safety Endpoints: μ_X = fraction in group X (all-cause mortality, MI, repeat coronary revascularization, or stroke at 30-days from PCI)

Null Hypothesis: $\mu_{\text{NON-SOS}} / \mu_{\text{SOS}} \geq 1.50$

Alternative: $\mu_{\text{NON-SOS}} / \mu_{\text{SOS}} < 1.50$

Rejection of the Effectiveness Null hypothesis implies that elective angioplasty is not inferior in terms of efficacy in sites without SOS while rejection of the Safety Null hypothesis implies that elective angioplasty is not less safe in sites without SOS.

5.3 ANALYTICAL STRATEGY:

All analyses will utilize intention to treat principles. A two sample-test of proportions using the Farrington and Manning approach will be employed. Safety and efficacy endpoints will be analyzed separately.

5.4 SAMPLE SIZE CONSIDERATIONS:

Expected event rates

The expected event rates are assumed to be the same for SOS and NON-SOS arms, in accordance with the alternative hypothesis of non-inferiority. The expected event rates are estimated based on data from the EVENT (Evaluation of Drug Eluting Stents and Ischemic Events) Registry-a multicenter registry of unselected patients undergoing PCI which evaluated 30-day and 1-year outcomes[20]. The EVENT Registry was chosen as it is a real world cohort of patients enrolling both acute coronary syndrome (ACS) and non ACS patients with similar entry criteria as the Mass Comm study. The expected rates from wave 4 of the registry by using a cohort of patients similar to the Mass-Comm study were approximately 6.2% for 30-day MACE and 15.8% for 12-month MACE (Unpublished data on file at HCRI). Hence in the present study we can assume event rates between 15-16% for the 12-month efficacy endpoint of MACE and 6-7% for the 30-day safety endpoint of MACE.

Sample size determination

Assuming an overall experiment-wise Type I error rate of 0.10 (0.05 for effectiveness and 0.05 for safety), a two-sample test of non-inferiority for proportions using the Farrington and Manning approach, and non-inferiority margin of 30% above the control rate (ratio < 1.30) for efficacy (12 month rates) and 50% above the control rate (ratio < 1.5) for safety (30-day rates), the sample of 3447 evaluable patients: 2585 in the NON-SOS arm and 862 in the SOS arm (3:1 randomization) will yield 85-88% power for the efficacy endpoint and 80-85% power for the safety endpoint. To account for attrition (missing completely at random) these numbers were inflated by 7%, yielding a total randomized sample of 3690 patients, with 2767 in the NON-SOS arm and 923 in the SOS arm.

6.0 DEFINITIONS

ABRUPT CLOSURE

Abrupt Closure. Defined as the occurrence of new (during the index procedure) severely reduced flow (TIMI grade 0-2) within the target vessel that persisted and required rescue by stenting or other treatment, or resulted in myocardial infarction or death. Abrupt closure requires proven association with a mechanical dissection of the treatment site or instrumented vessel, coronary thrombus, or severe spasm. Abrupt closure does not connote “no reflow” (due to microvascular flow limitation), in which the epicardial artery is patent but had reduced flow. Abrupt closure also does not connote transient closure with reduced flow in which the index treatment application does reverse the closure.

Subabrupt Closure. Defined as abrupt closure that occurred after the index procedure is completed (and the subject left the catheterization laboratory) and before the 30-day follow-up endpoint.

Threatened Abrupt Closure. Defined as a grade B dissection and $\geq 50\%$ diameter stenosis or any dissection of grade C or higher.

APPROPRIATENESS OF REVASCULARIZATION

Defined as the proportion of lesions meeting Class I and II criteria per the AHA/ACC/SCAI 2005 Guideline Update for PCI (see, Manual of Operations) or subsequent modifications thereof.

COMPLETENESS OF REVASCULARIZATION

Defined as proportion of epicardial vessels with $>70\%$ and $<100\%$ stenosis treated with procedural success.

BLEEDING COMPLICATIONS

Defined as a study procedure related hemorrhagic event requiring > 1 unit transfusion, prolongation of hospital stay, and/or a drop in hemoglobin > 3.0 gm/dl.

CANADIAN CARDIOVASCULAR SOCIETY CLASSIFICATION (CCS)

- Class I*** Ordinary physical activity does not cause angina, such as walking and climbing stairs. Angina with strenuous or rapid or prolonged exertion at work or recreation.
- Class II*** Slight limitation of ordinary activity. Angina upon walking or climbing stairs rapidly, walking uphill, walking or stair climbing after meals, or in cold, or in wind, or under emotional stress, or only during the first hours after awakening. Angina if walking more than two blocks on the level and climbing more than one flight of ordinary stairs at a normal pace and in normal conditions.
- Class III*** Marked limitations of ordinary physical activity. Walking one to two blocks on the level and climbing one flight of stairs in normal conditions and at a normal pace.
- Class IV*** Inability to carry on any physical activity without discomfort. Angina syndrome may be present at rest.

DE NOVO LESION

Defined as a native coronary artery lesion not previously treated.

DEATH

Death is divided into 2 categories:

Cardiac death is defined as death due to any of the following:

1. Acute myocardial infarction.
2. Cardiac perforation/pericardial tamponade.
3. Arrhythmia or conduction abnormality.
4. Stroke within 30 days of the procedure or stroke suspected of being related to the procedure.
5. Death due to complication of the procedure, including bleeding, vascular repair, transfusion reaction, or bypass surgery.
6. Any death in which a cardiac cause cannot be excluded.

Non-cardiac death is defined as a death not due to cardiac causes (as defined above).

DISSECTION, NHLBI (National Heart, Lung, and Blood Institute) CLASSIFICATION

- Type A*** Small radiolucent area within the lumen of the vessel disappearing with the passage of the contrast material.
- Type B*** Appearance of contrast medium parallel to the lumen of the vessel disappearing within a few cardiac cycles.
- Type C*** Dissection protruding outside the lumen of the vessel persisting after passage of the contrast material.
- Type D*** Spiral shaped filling defect with or without delayed run-off of the contrast material in the antegrade flow.
- Type E*** Persistent luminal filling defect with delayed run-off of the contrast material in the distal lumen.
- Type F*** Filling defect accompanied by total coronary occlusion.

DISTAL EMBOLIZATION

Defined as a new abrupt cut off of contrast column or filling defect distal to the treated lesion.

ELECTIVE PERCUTANEOUS CORONARY INTERVENTION

Defined as a planned percutaneous coronary intervention performed on a (for our purposes, “elective” means non-emergency) non-emergency basis to treat blockage that is $\geq 50\%$ and is believed to be the source of ischemic coronary symptoms.

EMERGENCY REVASCULARIZATION

Defined as immediate transfer for surgery related to a procedural complication or immediate repeat PCI or surgery for stent thrombosis or vessel occlusions that occur after leaving the cath lab.

INCOMPLETE APPPOSITION

Failure of the stent to completely appose to the vessel wall after placement is defined as one or more stent struts separated from the vessel wall with evidence of blood speckles behind the strut in the ultrasound image.

LESION CLASS (American College of Cardiology/American Heart Association Class)

Type A Lesions: Minimally complex, discrete (length <10 mm), concentric, readily accessible, non angulated segment (<45°), smooth contour, little or no calcification, less than totally occlusive, not ostial in location, no major side branch involvement, and an absence of thrombus.

Type B Lesions: Moderately complex, tubular (length 10 to 20 mm), eccentric, moderate tortuosity of proximal segment, moderately angulated segment (>45°, <90°), irregular contour, moderate or heavy calcification, total occlusions <3 months old, ostial in location, bifurcation lesions requiring double guidewires, and some thrombus present.

Type C Lesions: Severely complex, diffuse (length >2 cm), excessive tortuosity of proximal segment, extremely angulated segments >90°, total occlusions >3 months old and/or bridging collaterals, inability to protect major side branches, and degenerated vein grafts with friable lesions.

LESION SUCCESS

Attainment of < 20 % residual stenosis of the target lesion using any percutaneous method.

MAJOR ADVERSE CARDIAC EVENT (MACE)

Defined as a composite endpoint of all cause mortality, myocardial infarction (Q wave and non-Q wave), repeat coronary revascularization of target vessel or non-target vessel (PTCA or CABG), or stroke.

MAJOR VASCULAR COMPLICATION

Defined as the occurrence of any of the following as a result of the index procedure:

1. Hematoma at access site >5 cm
2. False aneurysm
3. AV fistula
4. Retroperitoneal bleed
5. Peripheral ischemia/nerve injury
6. Procedure related transfusion
7. Vascular surgical repair or ultrasound compression required

MINIMAL LUMINAL DIAMETER (MLD)

Defined as the mean minimum lumen diameter derived (by the quantitative coronary angiography laboratory) from the average of two orthogonal views (when possible) of the narrowest point within the area of assessment - in lesion, in stent or in segment.

MYOCARDIAL INFARCTION

A positive diagnosis of myocardial infarction is made when one of the following criteria is met:

1. **Q wave MI:** (QMI) will require one of the following criteria:
 - 1.1. Chest pain or other acute symptoms consistent with myocardial ischemia and new pathological Q waves in two or more contiguous ECG leads as determined by independent review of the CEC, in the absence of timely cardiac enzyme data.
 - 1.2. New pathologic Q waves in two or more contiguous ECG leads as determined by independent review of the CEC and elevation of cardiac enzymes. In the absence of ECG data the CEC may adjudicate Q wave MI based on the clinical scenario and appropriate cardiac enzyme data.
2. **Non-Q Wave MI (NQWMI):** for this trial NQWMI will be defined using the following definitions:

2.1. FDA Definition:

Elevated CK \geq 2X the upper laboratory normal with the presence of elevated CK-MB (any amount above the institution's upper limit of normal) in the absence of new pathological Q waves

2.2. Additional Definition:

Elevation of post-procedure CK-MB levels to \geq 3 times normal.

NO REFLOW

Defined as a sustained or transient reduction in antegrade flow that is not associated with an obstructive lesion at the treatment site.

PERFORATION

Perforations will be classified as follows:

Angiographic perforation: perforation detected by the clinical site or the core laboratory at any point during the procedure.

Clinical perforation: perforation requiring additional treatment (including efforts to seal the perforation or pericardial drainage), or resulting in significant pericardial effusion, abrupt closure, myocardial infarction, or death.

Pericardial hemorrhage/tamponade: perforation resulting in cardiac tamponade.

PROCEDURAL SUCCESS

Attainment of <20 % residual stenosis of the target lesion and no occurrence of in-hospital MACE.

REINFARCTION

Defined as once a downward trend in cardiac enzymes (CK-MB) from index event is noted, any increase in CK-MBs 50% above prior nadir.

RESTENOTIC LESION

Defined as a lesion in a vessel segment that has undergone prior percutaneous treatment without stent placement.

REFERENCE VESSEL DIAMETER (RVD)

Defined as the average diameter of normal segments within 10 mm proximal and distal to the target lesion from 2 orthogonal views using QCA.

STENT THROMBOSIS

Stent thrombosis should be reported as a cumulative value over time and at the various individual time points as specified below. Time 0 is defined as the time point after the guiding catheter has been removed and the subject has left the Cathlab.

Timing:

Acute stent thrombosis ¹ :	0 – 24 hours post stent implantation
Subacute stent thrombosis ¹ :	>24 hours – 30 days post stent implantation
Late stent thrombosis:	>30 days – 1 year post stent implantation
Very late stent thrombosis:	>1 year post stent implantation

¹Acute or subacute stent thrombosis can also be replaced by the term early stent thrombosis.

Three categories of evidence define stent thrombosis: Definite, Probable, Possible

1) DEFINITE (EITHER BY ANGIOGRAPHIC OR PATHOLOGIC CONFIRMATION).

a. Angiographic confirmation of stent thrombosis is considered to have occurred if:

Thrombolysis In Myocardial Infarction (TIMI) flow is:

- i) TIMI flow grade 0 with occlusion originating in the stent or in the segment 5mm proximal or distal to the stent region in the presence of a thrombus².
- ii) TIMI flow grade 1, 2, or 3 originating in the stent or in the segment 5mm proximal or distal to the stent region in the presence of a thrombus²

AND at least one of the following criteria has been fulfilled within a 48 hours time window:

- 1) new onset of ischemic symptoms at rest (typical chest pain with duration >20 minutes)
- 2) new ischemic ECG changes suggestive of acute ischemia
- 3) typical rise and fall in cardiac biomarkers (refer to definition non-procedural related MI).

The incidental angiographic documentation of stent occlusion in the absence of clinical signs or symptoms is not considered a confirmed stent thrombosis (silent occlusion).

² Intracoronary thrombus [Ellis et al., Mabin et al., Capone et al.]

Non-occlusive thrombus:

Intracoronary thrombus is defined as a (spheric, ovoid or irregular) non-calcified filling defect or lucency surrounded by contrast material (on three sides or within a coronary stenosis) seen in multiple projections, or persistence of contrast material within the lumen, or a visible embolization of intraluminal material downstream.

Occlusive thrombus:

A TIMI 0 or TIMI 1 intra-stent or proximal to a stent up to the most adjacent proximal side branch or main branch (if originating from the side branch).

b. Pathologic confirmation of stent thrombosis:

Evidence of recent thrombus within the stent determined at autopsy or via examination of tissue retrieved following thrombectomy.

2) PROBABLE:

Clinical definition of probable stent thrombosis is considered to have occurred after intracoronary stenting in the following cases:

- 1) Any unexplained death within the first 30 days.
- 2) Irrespective of the time after the index procedure any myocardial infarction (MI), which is related to documented acute ischemia in the territory of the implanted stent without angiographic confirmation of stent thrombosis and in the absence of any other obvious cause.

3) POSSIBLE:

Clinical definition of possible stent thrombosis is considered to have occurred with any unexplained death from 30 days following intracoronary stenting until end of trial follow-up.

STROKE

Stroke is defined as a neurological deficit lasting more than 24 hours with a brain imaging study (if performed) showing infarction or hemorrhage.

TARGET LESION

The target lesion is the treated segment starting 5 mm proximal to the stent and ending 5 mm distal to the stent

TARGET LESION REVASCULARIZATION (TLR)

Defined as any repeat percutaneous intervention of the target lesion or bypass surgery of the target vessel.

Ischemia driven (e.g., clinically-driven) revascularizations are those in which the subject has a positive functional study, ischemic ECG changes at rest in a distribution consistent with the target vessel, or ischemic symptoms. Revascularization of a target lesion with an in-lesion diameter stenosis $\geq 70\%$ (by QCA) in the absence of the above-mentioned ischemic signs or symptoms is also considered clinically-driven. In the absence of QCA data for relevant follow-up

angiograms, the clinical need for revascularization is adjudicated using the presence or absence of ischemic signs and symptoms.

Non-clinically driven repeat target lesion revascularizations are those in which the subject undergoes a non-emergent revascularization for a diameter stenosis <50% (by QCA). Non-emergent repeat target lesion revascularization for a diameter stenosis <70% (by QCA) in subjects without either a positive functional study or angina are also considered non-clinically driven. Defined as any repeat revascularization of the target site whether by PCI or bypass surgery.

TARGET VESSEL (TV)

The target vessel is the entire major coronary vessel proximal and distal to the target lesion including upstream and downstream branches and the target lesion itself.

(For example: if the original lesion is the first obtuse marginal branch, the target vessel includes the left main coronary artery, the circumflex coronary artery and its branches).

Note: in three-vessel treatment every repeat revascularization becomes TVR.

TARGET VESSEL FAILURE (TVF)

Defined as a composite of target vessel revascularization (defined below), Q or Non Q-wave myocardial infarction, or cardiac death that could not be clearly attributed to a vessel other than the target vessel.

Target vessel failure is a more conservative and broader category than MACE and includes any target vessel revascularization as well as any MI or any cardiac death that cannot be clearly attributed to a non-target vessel. Target vessel failure, thus, includes any revascularization or adverse endpoint due to re-narrowing of any portion of the target vessel, and assumes that the entire vessel is vulnerable to late failures because of guide catheter or guide wire trauma or progression of disease remote from the treatment site.

Target vessel failure will be reported when any of the following events occur:

- MI occurs in territory not clearly other than that of the target vessel.
- Cardiac death not clearly due to a non-target vessel endpoint.
- Target vessel revascularization is determined.

TARGET VESSEL REVASCULARIZATION (TVR)

Defined as any repeat percutaneous intervention of the target vessel whether PCI or bypass surgery. Ischemia-driven TVR is defined the same as above for TLR.

TIMI CLASSIFICATION

TIMI 0 No perfusion.

TIMI 1 Penetration with minimal perfusion. Contrast fails to opacify the entire bed distal to the stenosis for the duration of the cine run.

TIMI 2 Partial perfusion. Contrast opacifies the entire coronary bed distal to the stenosis. However, the rate of entry and/or clearance is slower in the coronary bed distal to the obstruction than in comparable areas not perfused by the dilated vessel.

TIMI 3 Complete perfusion. Filling and clearance of contrast equally rapid in the coronary bed distal to stenosis as in other coronary beds.

URGENT REVASCULARIZATION

Surgery or repeat PCI required within 72 hours of index procedure or within 72 hours of acute recurrent ischemic event and related to recurrent or ongoing ischemia or otherwise unsuccessful index procedure.

7.0 ENDPOINT DATA COLLECTION AND STUDY ENDPOINTS

7.1. CLINICAL FOLLOW-UP

A clinical follow-up office visit will be scheduled at 30 days + 7 days and at 12 months \pm 30 days post-procedure for all patients. Clinical follow-up for determination of study endpoints is required for ischemia-driven revascularization of the target vessel (TVR), target lesion (TLR), non-target vessel (non-TVR), and major adverse cardiac events (see endpoints below).

In a randomly selected subset of patients (N=400) angiographic films will be submitted for analysis performed by a blinded core laboratory, to assess baseline angiographic characteristics, pre- and post-procedure lesion characteristics, completeness and appropriateness of revascularization.

7.2 PRIMARY ENDPOINT

The primary endpoint of this trial will be measured at 30 days (safety) and 12 months (efficacy). The primary endpoint is defined as the occurrence of death (from all cause), myocardial infarction, repeat coronary revascularization, or stroke.

7.3 SECONDARY ENDPOINTS

The secondary endpoints include both safety and efficacy measures and are as follows:

1. All cause mortality at 30 days and 12 months.
2. Stroke at 30 days and 12 months.
3. Ischemia driven TLR and TVR at 12 months.
4. Any coronary revascularization through month 12. Revascularization will be categorized according to relatedness to the target lesion or target vessel (e.g., as either target lesion or target vessel related or non-target lesion or non-target vessel related).
5. Rate of emergent revascularization through day 30.
6. Procedure success defined as lesion success without the occurrence of in-hospital MACE.
7. Major vascular complications, including access site complications and major bleeding events requiring transfusions, through day 30.
8. Completeness of revascularization, defined as proportion of epicardial vessels with $>70\%$ and $<100\%$ stenosis treated with procedural success.
9. Appropriateness of revascularization, defined as the proportion of lesions meeting Class I and II criteria per the 2005 Angioplasty Guidelines of AHA/ACC/SCAI or subsequent modifications thereof.

8.0 DATA SUBMISSION REQUIREMENTS

8.1 REQUIRED DATA

All required data for this trial will be collected via electronic case report forms (eCRF) and securely transferred by a 21 CFR Part 11 compliant electronic data capture (EDC) system.

8.2 DATA COLLECTION

Electronic Case Report Form Development, Modification and Maintenance: The final set of eCRFs is designed to accommodate the specific features of the trial design. Modification of eCRFs will only be made if deemed necessary by the Executive Operations Committee.

Components of the eCRF:

1. Baseline subject demographic and clinical data.
2. Procedure data (including stents used, procedural complications and drugs used during and after the procedure).
3. Hospital Discharge data (including post-procedural complications, ischemic or vascular complications, in-hospital major events, and pertinent laboratory tests).
4. Study endpoint event data.
5. Clinical event follow-up data related to study endpoints (includes incidence and timing of any ischemic or major clinical event from hospital discharge to study completion, such as death, MI, stroke or revascularization by a percutaneous procedure or CABG and indication of target vessel involvement).

8.3 DATA COLLECTION AND TRACKING

Research coordinators at each clinical site will perform primary data collection drawn from source document (hospital chart) reviews. Data will be entered by the site personnel into eCRFs on the internet-based EDC system. This will ensure data are forwarded to HCRI in an expedited fashion. If a subject is randomized to a SOS hospital from the enrolling non-SOS hospital, the research coordinator from the SOS hospital will enter the data from their patients who were treated through discharge. The enrolling non-SOS hospital research coordinators are then ultimately responsible for ensuring that all the patients' follow-up data are entered into the study database through the EDC system. HCRI will provide clinical monitoring, including review of EDC data with verification to the source documentation on approximately 10% of the subjects enrolled. This will include operator worksheets retained with eCRF documentation and hospital charts.

In the initial phase of the protocol, periodic teleconference calls between the Executive Operations Committee, HCRI and each clinical site may be performed to resolve any problems concerning the protocol and data collection. Periodic recruitment status reports generated by the EDC system will identify variations in recruitment frequency among sites.

8.4 TIME WINDOWS FOR EXPECTED COMPLETION OF ELECTRONIC CASE REPORT FORMS/REPORTS

The eCRF data submission detailed in the following table should be completed as follows:

Table 4: Responsibilities for Submitting eCRFs

Type of eCRF	Prepared by Investigator For	Time of Notification
Subject Enrollment eCRF	HCRI	Within 24 hours of enrollment
Baseline eCRF	HCRI	Within 7 days of enrollment
Hospital Discharge Form eCRF	HCRI	Within 7 days of discharge
Clinical Follow-up eCRFs	HCRI	Within 7 days of subject visit
Study Endpoint Notification eCRF	HCRI, IRB	Within 24 hours of knowledge of event
Study Exit Form	HCRI	Within 7 days of subject visit

Other data and reports detailed in the following table should be submitted (by fax, mail, or overnight courier, if necessary) to HCRI, the Executive Operations Committee (via HCRI) or the IRB as follows:

Table 5: Responsibilities for Submitting Reports and Other Data

Type of Report	Prepared by Investigator For	Time of Notification
Screening Logs	HCRI	Submit to HCRI weekly
Informed consent not obtained from subject	Executive Operations Committee (via HCRI), IRB	Within 5 working days of index procedure
Subject death during the investigation	Executive Operations Committee, HCRI and IRB	Within 1 day of knowledge of event
Withdrawal of IRB approval	Executive Operations Committee, HCRI	Within 5 days of withdrawal
Annual reports	Submit to IRB	Annually
Final report	IRB	Within 3 months of study completion or termination

9.0 STUDY RESPONSIBILITIES

9.1 INVESTIGATOR RESPONSIBILITY FOR STUDY CONDUCT

Study investigators will ensure that all work and services they provide will be conducted in compliance with the standards of good clinical and research practice. It is the responsibility of each study-site principal investigator to provide the current study protocol to all sub-investigators

and other staff responsible for study conduct, as well as provide for the training of all sub-investigators or other staff involved in the conduct of this research.

Upon completion of the trial, the principal investigator will submit a final written report to the reviewing Institutional Review Board within three (3) months of completion or termination.

9.2 SELECTION AND MONITORING OF CLINICAL SITES AND OPERATORS

In the selection of study investigators, the Massachusetts Department of Public Health (MDPH) requires each interventionalist to have adequate experience with percutaneous coronary interventional devices, demonstrate commitment to patient safety and consistency in adherence to study protocols. The MDPH will closely monitor compliance with the protocol throughout the study.

Each study site will be subject to on-going monitoring. Study sites will be evaluated for meeting enrollment criteria and for the accurate and timely submission of data forms, catheterization or surgical reports (as requested for event adjudication) and timely response to data queries from the study monitors or data coordinating center.

9.3 STUDY CLOSEOUT

Upon completion of the clinical study (when all subjects enrolled have completed the follow up visits and the eCRFs and queries have been completed) a study closure visit will be performed. The Monitor will ensure that the investigator's regulatory files are up to date and complete and that any outstanding issues from previous visits have been resolved. Other issues which will be reviewed at this visit include: discussing retention of study files, possibility of site audits, publication policy, and to ensure that the investigator will notify the local IRB regarding study closure.

9.4 AUDITS/INSPECTIONS

In the event that audits are initiated by the sponsor's representative (HCRI) or local regulatory authority, the investigator shall allow access to the original medical records and provide all requested information.

9.5 PUBLICATION POLICIES

At the conclusion of the study, a multi-center publication will be prepared for publication in a reputable scientific journal. The publication of the principal results from any single center experience within the trial is not allowed until the preparation and publication of the multi-center results. Exceptions to this rule require the prior approval of the Executive Operations Committee and/or MA-DPH. The analysis of other pre-specified and non pre-specified endpoints will be performed at HCRI. Such analyses, as well as other proposed investigations by members of the Steering Committee, will require the approval of the Executive Operations Committee. Several secondary manuscripts are anticipated with principal authorship drawn from members of the Steering Committee. For purposes of timely abstract presentation and publication, such secondary publications will be delegated to the appropriate principal authors, and final analyses and manuscript review for all multi-center data will require the approval of the Executive Operations Committee and MA-DPH.

10.0 STUDY COMMITTEES

10.1 EXECUTIVE OPERATIONS COMMITTEE

The Executive Operations Committee will be responsible for the day-to-day administrative management of the trial. This committee will meet periodically (at least quarterly) by teleconference to monitor subject enrollment, clinical site progress, and protocol compliance. This committee will be responsible for reviewing the final results, determining the methods of presentation and publication, and selection of secondary projects and publications proposed by members of the Steering Committee.

The Executive Operations Committee may appoint an Independent Review Committee to review cases of protocol violations where PCI was not performed post-randomization. The review will consist of clinical and angiographic evidence in the medical record and reason provided by post-randomization interventionalist who makes the decision to forego PCI in the randomized patient. It is expected that such independent case review will be rarely required throughout the study, but will be performed for each instance when PCI is not performed post-randomization. Subjects randomized but not treated with PCI will remain in the randomized and analyzed subject population. Members of the Independent Review Committee will be announced to all site PIs.

Alice Jacobs, MD	Principal Investigator, BUMC
Laura Mauri, MD, MSc	Co-PI, BWH, HCRI
Sharon-Lise Normand, PhD	MASS-DAC, Co-PI, HMS
Donald Cutlip, MD	Clinical Event Adjudication, HCRI
Paul Dreyer, PhD	Director, Bureau of Quality Assurance and Control, MADPH
Joseph Carrozza, MD	SOS Hospital Representative
Anthony Marks, MD	Non-SOS Hospital Representative

10.2 CLINICAL EVENTS COMMITTEE

The Clinical Events Committee is made up of interventional and non-interventional cardiologists who are not participants in the study. The Clinical Events Committee will meet regularly to review and adjudicate all clinical endpoints. The Clinical Events Committee is charged with the adjudication of clinical endpoint events according to the definitions outlined in the protocol.

At the onset of the trial, the Clinical Events Committee will establish explicit rules outlining the minimum amount of data required, and the algorithm followed in order to classify a clinical endpoint event. The Committee will also review and rule on all deaths that occur throughout the trial. All members of the Clinical Events Committee will be blinded to the primary results of the trial.

Once the specific criteria for clinical endpoints are established by the Clinical Events Committee, the Harvard Clinical Research Institute (HCRI) will be responsible for categorizing all clinical endpoint events when all necessary data are available.

10.3 DATA SAFETY MONITORING BOARD

The Data Safety Monitoring Board (DSMB) is composed of at least five members (four physicians from the fields of cardiology and interventional cardiology and one bio-statistician), who are not directly involved in the conduct of the trial. The DSMB will review the study on a periodic basis to be defined at their first meeting. The DSMB will meet twice yearly after approximately 1000, 2000, 3000, and final 3960 subjects have been enrolled and have 30 day follow-up data available for review. The DSMB is empowered to call additional meetings or revise the interims by which data is reviewed.

Based on the safety data, the DSMB may recommend that the Executive Committee modify or stop the trial. All final decisions, however, regarding trial modifications, rest with the Executive Committee. No formal statistical rule for stopping the trial will be defined.

10.4 STEERING COMMITTEE

The Steering Committee consists of members of the Executive Operations Committee and all clinical site principal investigators.

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